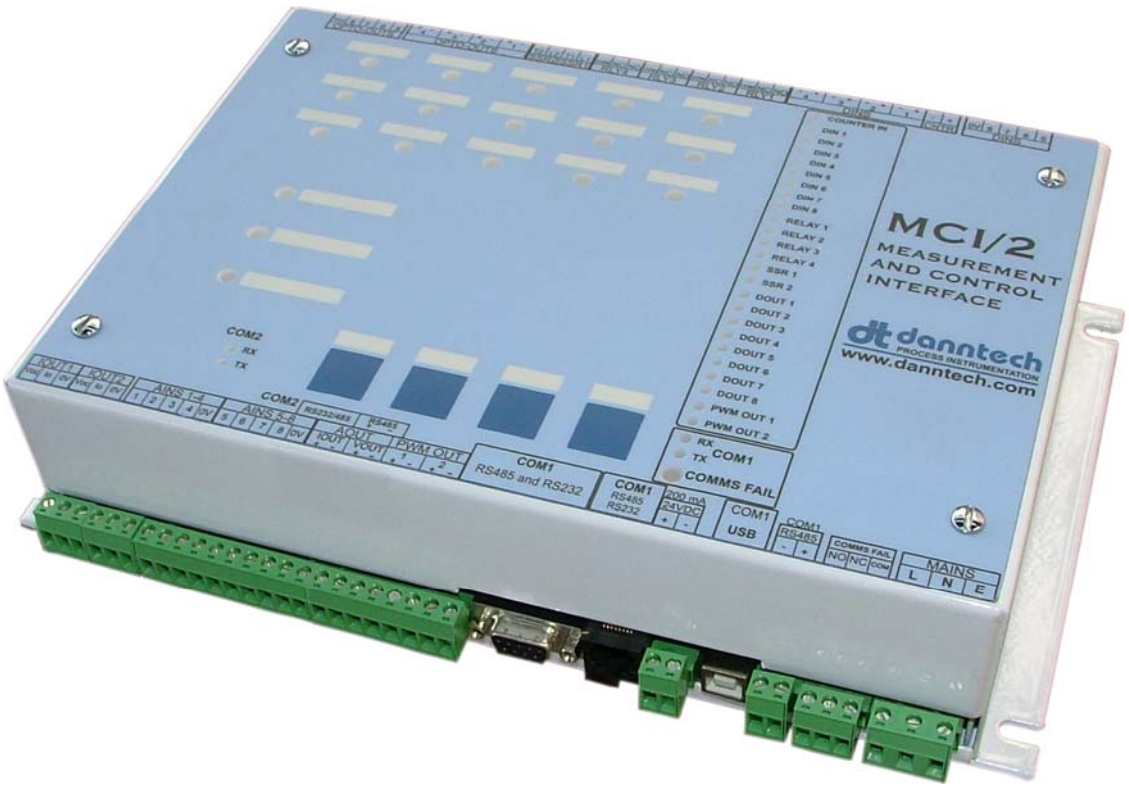
MCI/2
Measurement and Control Interface



User Manual

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1. What is Included with your MCI

The MCI/2
User Manual
Power Cable
RS232 Interface Cable DSUB9 to DSUB9
USB Interface Cable
RS232 Interface Cable RJ45 to DSUB9
MCI/2 CD

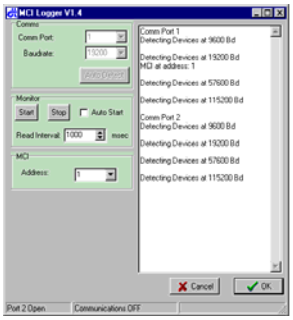
1. MCI/2 CD Contents

1.1. Applications
MCI application details (HTML), MCI applications (PDFs).

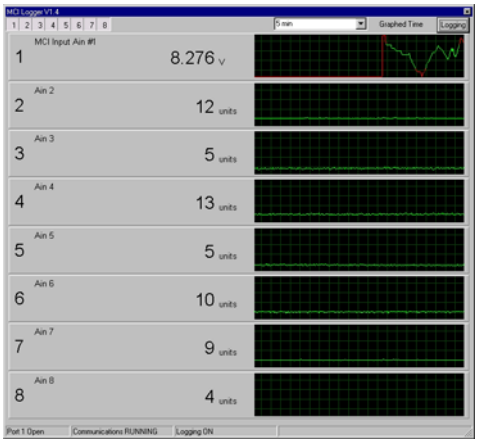
1.2. Brochures
Various related product brochures.

1.3. MCI/2 User Manual
PDF version of this user manual in high resolution and low resolution formats.

1.4. MCI Logger
Logging and graphical display program for use with the MCI/2.

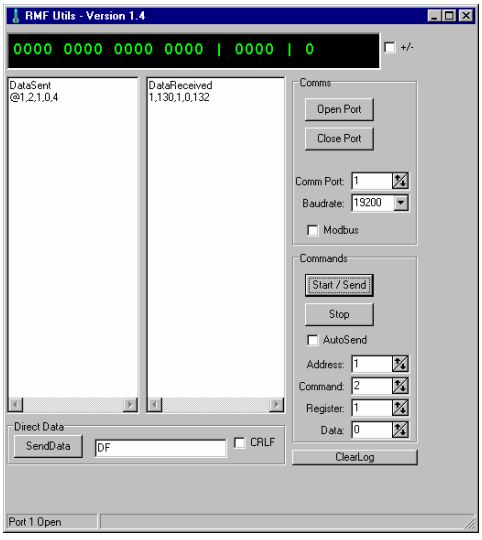


Generalised data logging program which allows the MCI/2 to be used to log and display graphically up to eight analogue inputs. Excel compatible data file.



1.5. RMF Utils
General Danntech Remote Magic and Modbus communications test program for sending and receiving Danntech RMF Communications or Modbus commands.

Useful for preliminary testing and verifying that the communications ports and connections are working correctly.



1.6. Spreadsheets
Excel Worksheet with Command and Register Details.

1.7. USB Drivers
Drivers for Win 2000, Win XP and Win 98.

2. Introduction to the MCI/2

The Measurement and Control Interface (MCI) provides a powerful interface for doing process control, data acquisition and logging.

In its basic form, the MCI is a “dumb” device, i.e. it must be used with a controller of some sort – typically a PC but could be a PLC or any other controlling device.

RS232, RS485 and USB interfaces are provided for connecting to the MCI. Applications which may require several data acquisition or control points - up to 32 MCIs can be can be multi-dropped on one pair of twisted wires at a distance of up to 1 000 metres.

Customized applications can be developed using Visual Basic, Delphi and C. An Active-X Control is also available for the Remote Magic Family Interface which allows direct use with Microsoft Excel, Visual Basic, C or any other Windows program which supports Active-X.

The MCI is useful in any laboratory where simple logging or control is required using a personal computer. In this case the user can write a program to do exactly the job required. Larger applications can be developed using more that one MCI spread over 1,000 metres with the two wire RS485 interface which allows the location of the hardware close to the process. Communications signal isolation affords protection of the controlling equipment against high industrial potentials, surges and spikes. Eighteen front panel LEDs can be controlled and used to indicate various things.

Internally the MCI comprises of two printed circuit boards.

The Interface Board: at the bottom, which has the main processor and all the plug-in screw terminal connections and the

Display Board: mounted in the top cover with the LEDs and auxiliary connectors

The MCI can be located simply on a desktop or screwed vertically to a panel. For permanent mounting four holes are provided in the MCI bottom corners for bolting the MCI securely vertically or horizontally.

3. Applications

LABORATORY - Controlling of experiments, logging of results for analysis using other applications, dynamic display of experimental results, temperature profile control.

PRODUCT TESTING - Production line quality assurance, linearity measurements of input-output devices, logging of temperature performance, monitoring of products undergoing burn-in.

ENERGY MANAGEMENT - Logging of energy consumption, switching of reactive compensators, warning and monitoring of maximum demand, controlled load shedding, timed switching.

TEST AND MEASUREMENT SYSTEMS - Easy integration with Labview and other block diagram type programs. Direct program control provides sophisticated control of purpose designed equipment. We can write specialized software to suit your application.

PROCESS CONTROL - Level control, PID loops, temperature control, system monitoring and logging.

EDUCATION - Waveform generation, introductory computer control, PID and ON/OFF control system design, very low frequency synthesis, easy to use I/O platform for projects, full PC source code for integration into new applications.

- Galvanic isolation of plant signals from the controller.
- Remote monitoring of a mixture of analogue and digital signals.
- Simple remote control using the various inputs and outputs.
- The concentration of a mixture of plant signals down to a pair of wires up to 1,000 metres long to minimise plant wiring thereby reducing the cost.
- The distant switching of equipment without the need to run mains wiring.
- The ability to provide a mixture of remote analogue measurement and control outputs on any network.

Systems implemented using the Measurement and Control Interface – (details on the MCI/2 CD or www.danntech.com website):

- Electroplating Control System
- Leach Plant Control System
- Crystallization Plant Control
- Irrigation Multi-Acid pH Control System

- Distributed Ammonia Gas Monitoring System
- Stack Gas Monitoring System
- Automated Dilution of Hydrochloric Acid
- Galvanostatic/Potentiostatic Measurement Control System
- Fabric Dying Control System
- Cheese Factory Cleaning Cycle and Pasteurizer Monitoring
- 2 MW DC Furnace Monitoring
- Bacterial Growth Control System
- Mini-Cell Test System
- Motor Current Monitoring System

We can also write customised firmware for the MCI/2 to suit your application where several units are required and the cost benefit can be realised. A once-off firmware charge based on the time required implementing your unique functions and then a standard cost thereafter.

4. Educational Possibilities

Computer Skills / IT Educators / Practical Programming

Now you can teach (or learn) how to develop more than "passive" programming and computer skills. We have a simple, powerful and practical PC interface which enables the student to actually switch things on and off, measure voltages or currents, count events and detect switch closures.

The Measurement and Control Interface (MCI) adds a very practical and immediately rewarding programming experience.

Using any of our software interfaces which are easy to understand, students can quickly explore the power of using programs to perform practical and useful functions.

We have several practical "add-ons" such as:
Floor mat switch
Passive infra red sensor
Magnetic switches
Push-button switches
Proximity sensors

Lamp
Buzzer
Temperature sensor
Level switch
Water flow valve
Motor and speed controller
Power supply

Supplied free of charge are various software examples and interface for use directly with programs such as Excel, Visual Basic, Delphi, C++ and Visual C.

These tools gives the student practical meaning to programming and bridges the gap between a powerful programmable device (the PC) and the real world. Say goodbye to programs which just say “hello world” or are contrived to try and be of practical use.

Our Measurement and Control Interface (MCI) can switch several high power devices directly, measure up to eight voltage or current inputs, detect the status of four switches, switch any of the 15 light emitting diodes (LEDs) amongst other things.

Requires a free com port, a 486 or more powerful PC will do, along with the creativity to explore.

5. Features

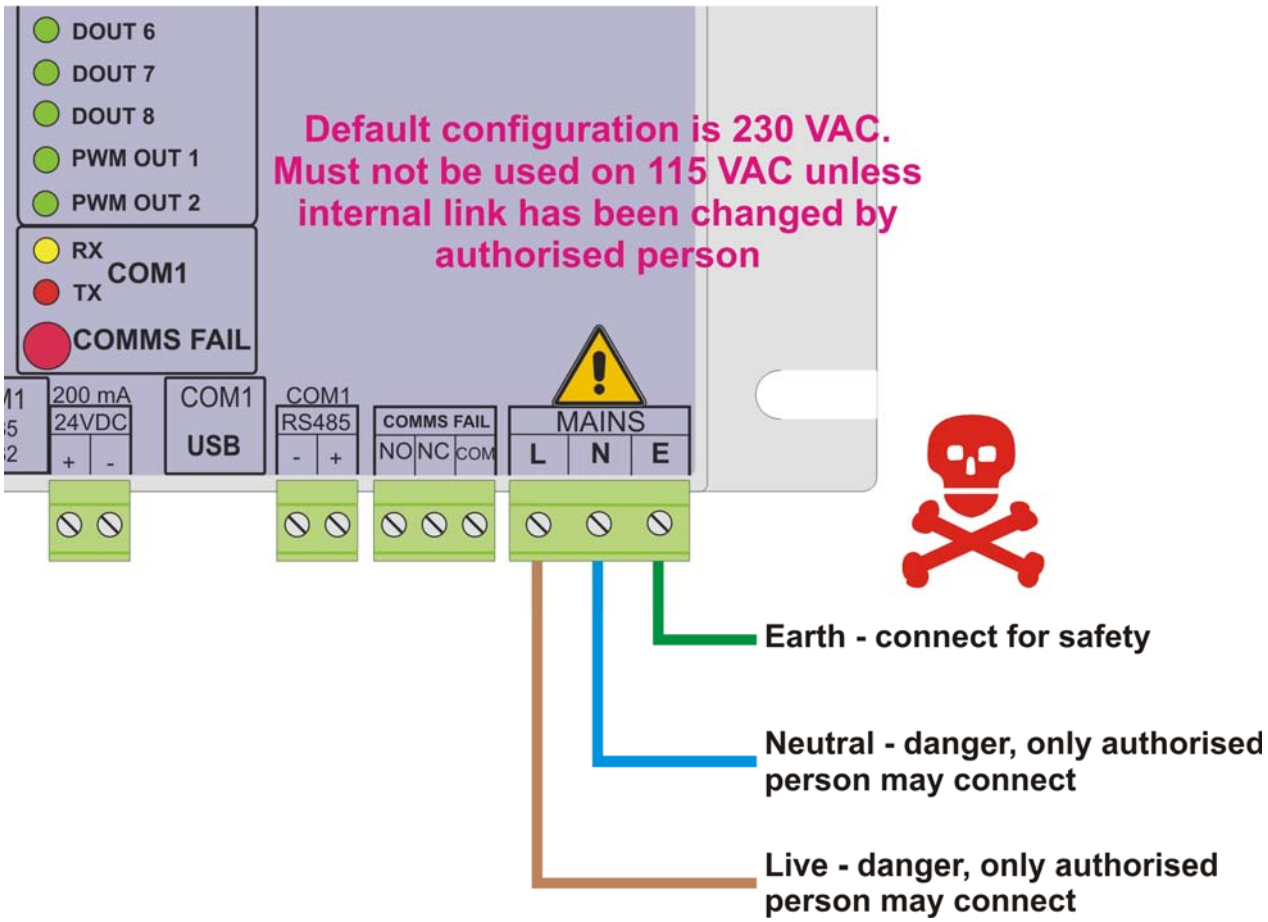
- Eight 16 bit analogue inputs (0 to 10 V, 0 to 20 mA or 4 to 20 mA)
- Eight digital inputs - four individually isolated, four with common 0V (0 to 12V or 0 to 30 V input)
- One high speed sixteen bit counter input (0 to 12V or 0 to 30 V input, counter or frequency modes)
- Four relays (120 VAC/10 A, 240 VAC/6 A, 24 VDC/10 A)
- Two solid state relays (240 VAC/3A)
- Eight digital outputs - four individually isolated, four with common Vcc connections
  (40 V/100mA)
- Two pulse width modulated outputs (30 V/50 mA)
- Three analogue outputs – one non-isolated, self powered 12 bits, 0 to 22.5 mA and 0 to 10.5 V

  - two isolated, externally powered, 16 bits,

derived from the PWM outputs, 0 to 22 mA and 0 to 11 V

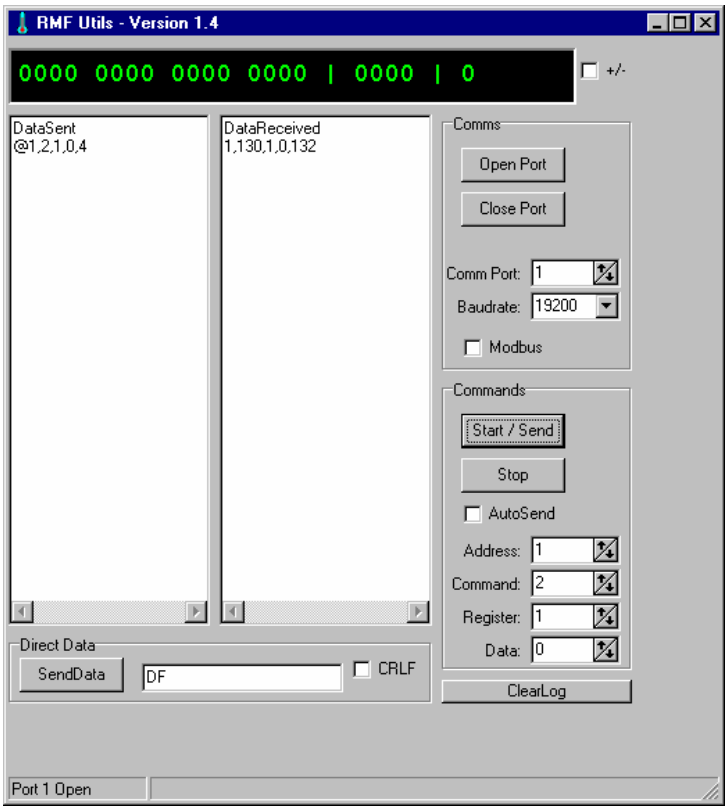
- Auxiliary 24 V 200 mA isolated DC supply for external devices.
- Eighteen user controllable front panel LEDs with flashing capability
- LED status indication of all digital inputs, digital and relay outputs on front panel
- Communications fail relay LED indication and relay output (120 VAC/10 A, 240 VAC/6 A, 24 VDC/10 A)
- Interface -serial RS232, RS485 and USB – optically isolated from the MCI internal circuitry
- 230 VAC powered (also 115 VAC by changing internal link)
- Robust industrial enclosure
- Plug-in screw terminal connections
- Backward software compatibility with older version
- Physical compatibility with older version – same mounting screws and same plug-in connections.

6. Safety


DOUT 6
DOUT 7
DOUT 8
PWM OUT 1
PWM OUT 2
RX
TX
COM1
COMMS FAIL
Default configuration is 230 VAC.
Must not be used on 115 VAC unless
internal link has been changed by
authorised person
200 mA
24VDC
+
-
COM1
USB
COM1
RS485
-
+
COMMS FAIL
NO
NC
COM
MAINS
L
N
E
Earth - connect for safety
Neutral - danger, only authorised
person may connect
Live - danger, only authorised
person may connect

7. Getting Up and Running Quickly

The quickest way to get up and running is to find the communications cable that you want to use – the DSUB RS232, the RJ45 serial or the USB connection cables. If you plan to use the USB cable check out and install the USB drivers.



Connect up the MCI and power it up. The LEDs should flash once when power is applied.

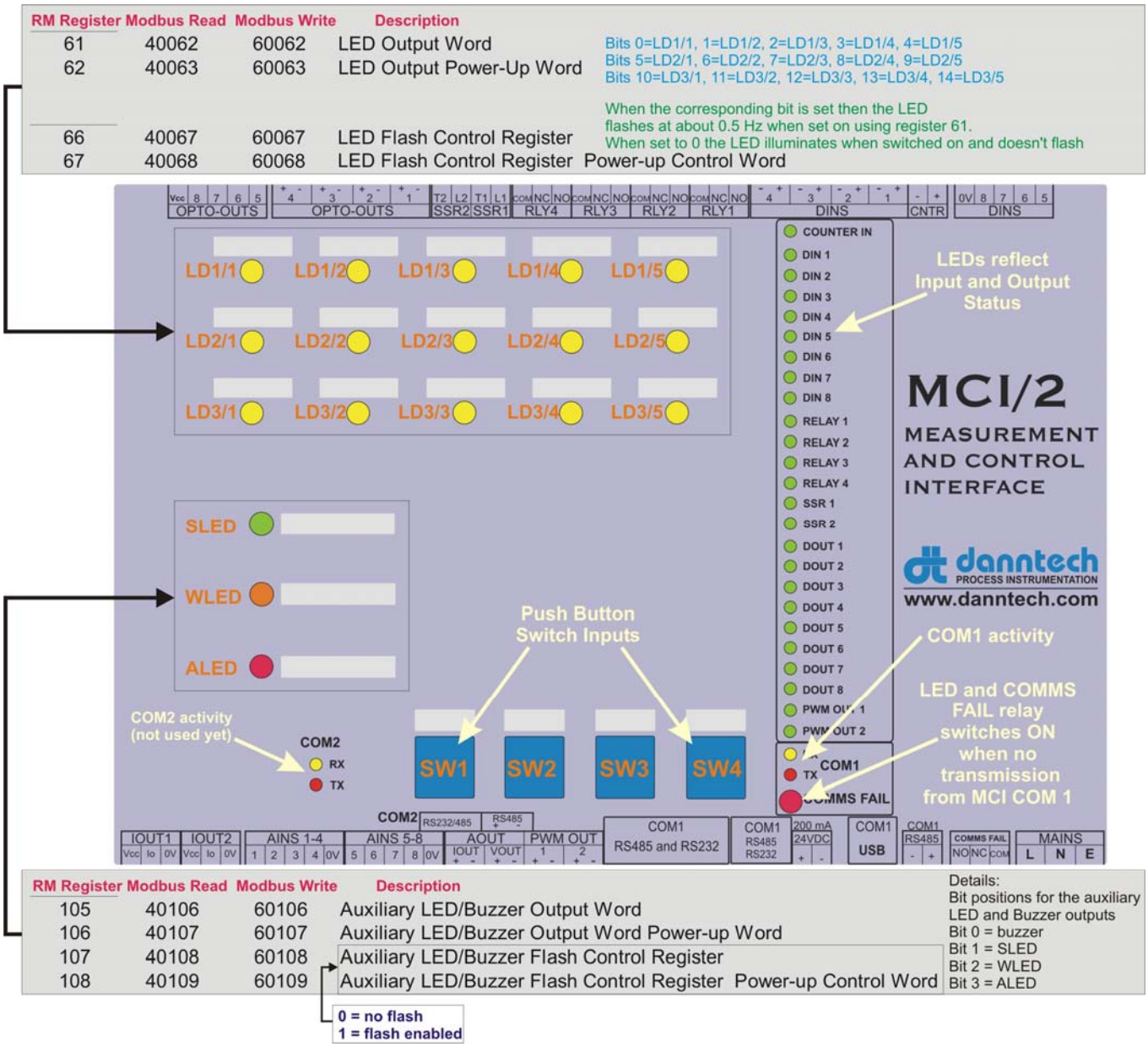
Now find and run the RMF_Utility.exe, select the correct communications port and 19,200 bits per second (if this is the same as when delivered).

Set up up the Address, Command, Register and Data as shown in the picture, open the port and press the Start/Send button. If all is well, the MCI/2 should reply as shown – i.e. with the reply:

1,130,1,0,32

If so, then all is OK. If there is no reply, check out all the settings and connections until a reply is received.

8. Front Panel and LED Details



Fifteen plus three LEDs are available to the user, these can be switched on or off or made to flash when switched on or off. Each LED can be configured to flash or not and then when switched on or off will either remain on or flash. Label areas are provided for each LED so that they can be labelled to suit the application.

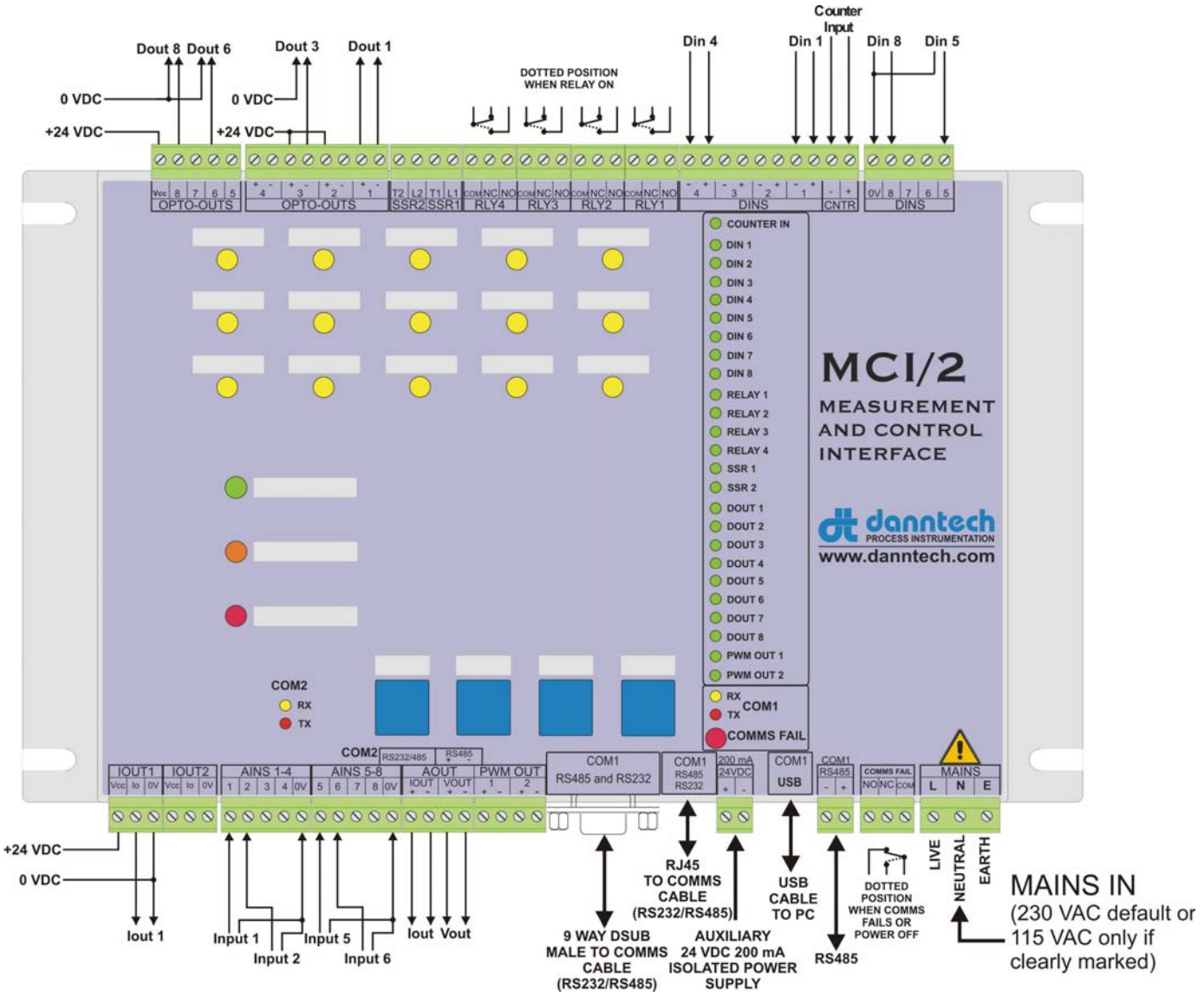
There is also a buzzer available inside the MCI which can be controlled.

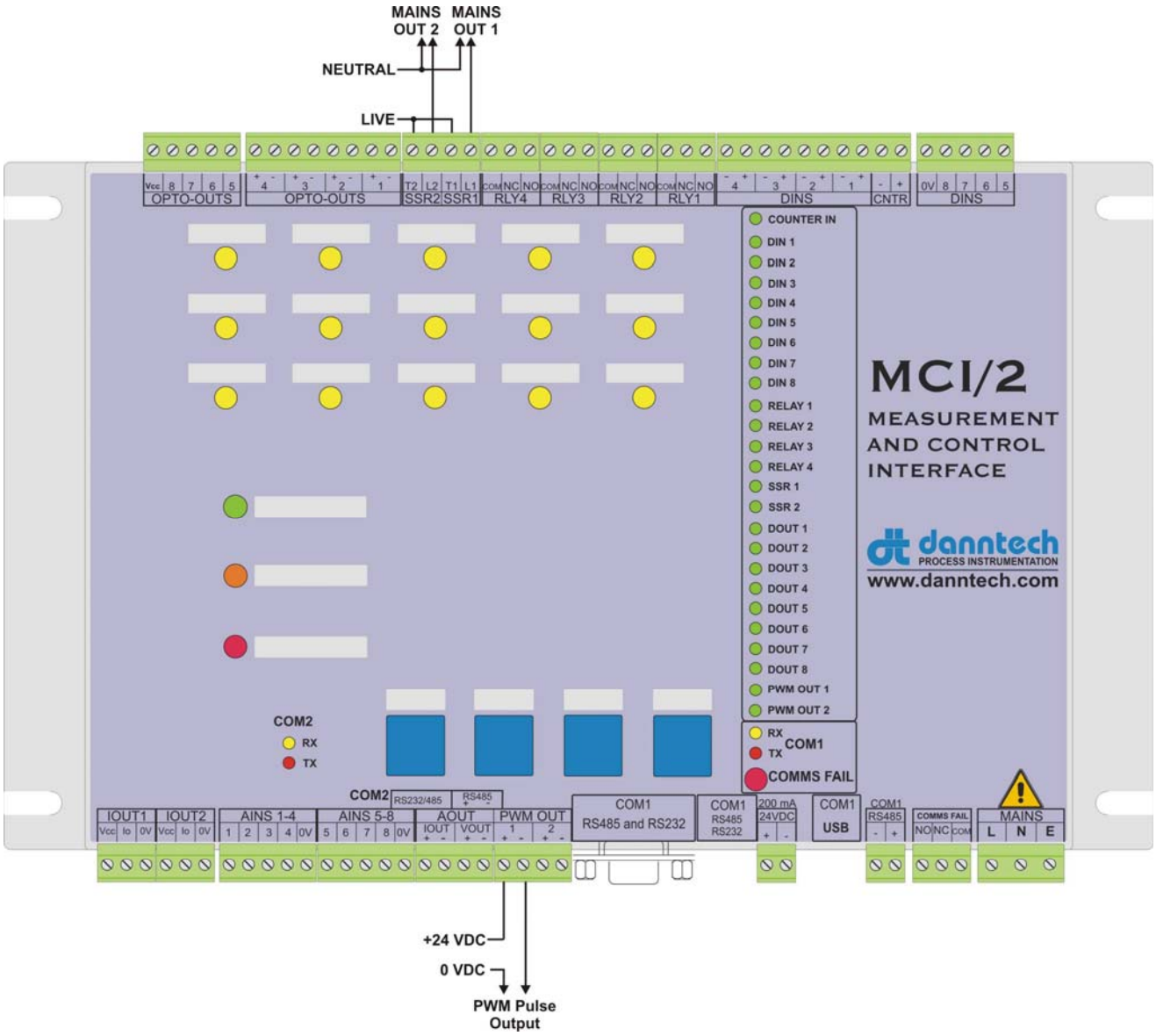
All the input and output states are also indicated using the row of green LEDs.

All of the LED outputs (not isolated) and switch inputs are also made available on the Auxiliary connectors for advanced users and future digital output expansion.

Each LED has a power-up setting as well as a power-up flash control setting.

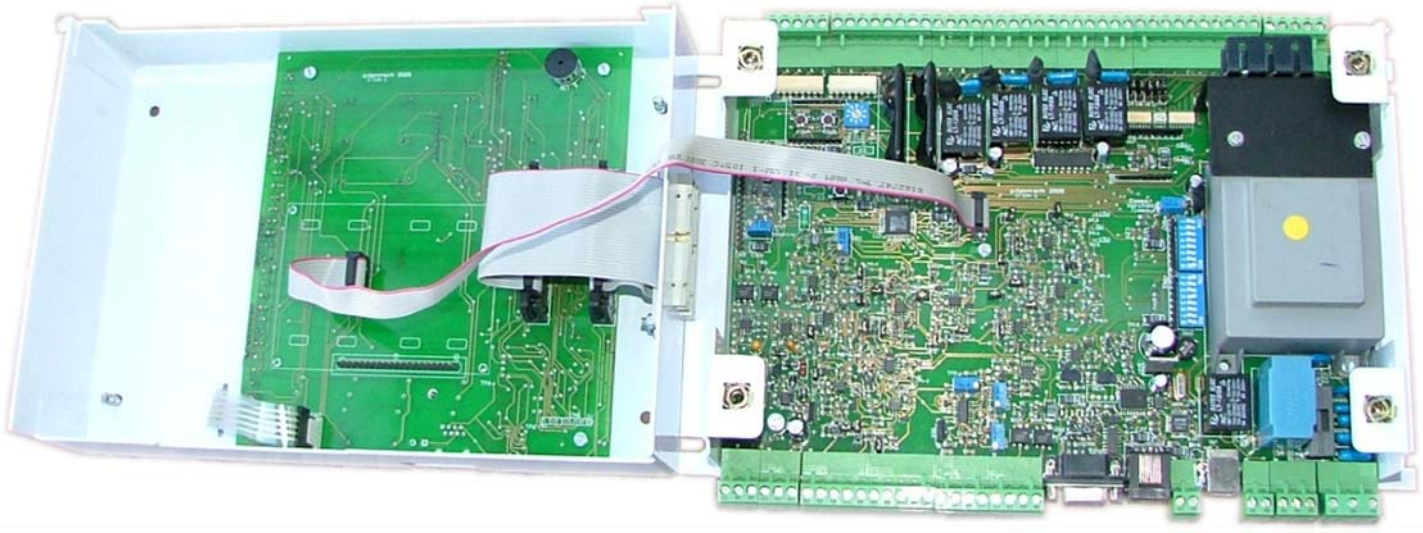
9. Physical Connections




MAINS OUT 2
MAINS OUT 1
NEUTRAL
LIVE
OPTO-OUTS
OPTO-OUTS
SSR2
SSR1
RLY4
RLY3
RLY2
RLY1
DINS
CNTR
DINS
COUNTER IN
DIN 1
DIN 2
DIN 3
DIN 4
DIN 5
DIN 6
DIN 7
DIN 8
RELAY 1
RELAY 2
RELAY 3
RELAY 4
SSR 1
SSR 2
DOUT 1
DOUT 2
DOUT 3
DOUT 4
DOUT 5
DOUT 6
DOUT 7
DOUT 8
PWM OUT 1
PWM OUT 2
MCI/2
MEASUREMENT AND CONTROL INTERFACE
danntech
PROCESS INSTRUMENTATION
www.danntech.com
COM2
RX
TX
COM1
RX
TX
COMMS FAIL
COM2
RS232/485
RS485
IOUT1
IOUT2
AINS 1-4
AINS 5-8
AOUT
PWM OUT
COM1
RS485 and RS232
COM1
RS485
RS232
200 mA
24VDC
COM1
USB
COM1
RS485
COMMS FAIL
MAINS
+24 VDC
0 VDC
PWM Pulse Output

10. Removing the Cover and Getting Inside

Four quarter-turn screws are used to fasten the lid.



11. DIP Switches

SW1 selects the following:

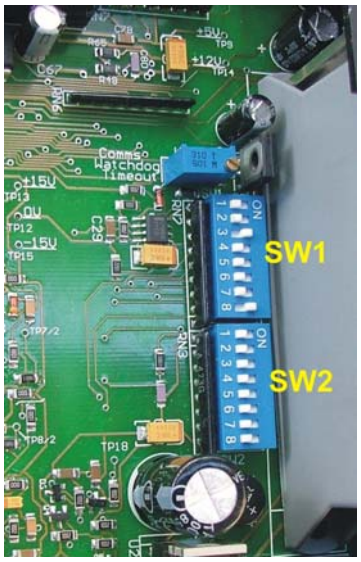
SW1.1 - Communications speed:	0 (off) = 19,200 or 115,200 bits/sec 1 (on) = 9,600 or 57,600 bits/sec
SW1.2 – not used:	
SW1.3 – Communications speed range: (used with SW1.1)	0 (off) = low range 9,600 and 19,200 bits/sec 1 (on) = high range 57,600 or 115,200 bits/sec
SW1.4 to SW1.8 - Device address -	Binary with SW1.4 = MSB and SW1.8 = LSB

SW2 selects the following:

SW2.1 – Communications medium select – always ON

SW2.2 – Select Danntech Remote Magic Family Communications Protocol or Modbus	0 (off) = RMF 1 (on) = Modbus
Only SW2.4 is used: Manual input calibration control	0 (off) = normal operation 1 (on) = analogue input calibration

	SW1	OFF	ON
Communications Baudrate (depends on range selected)	1	9,600 or 57,600	19,200 or 115,200
Communications Baudrate Range	3	low range	high range
Not Used	2		
Address MSB	4		
	5		
	6		
	7		
Address LSB	8		



	SW2	OFF	ON
Always ON – selects RS232, RS485 and USB	1	Danntech RMF Protocol	Always ON
RMF or Modbus Select	2		Modbus
Not Used	3		
Manual Input Calibration	4	Normal	Calibrate
Not Used	5		
Not Used	6		
Not Used	7		
Not Used	8		

12. Jumper Option Selections

Analogue Inputs:

		J1/1	J1/2	J1/3
Analogue Input #1	0-10 V	A	out	out
	4-20 mA	B	in	in
	0-20 mA	B	out	out

		J2/1	J2/2	J2/3
Analogue Input #2	0-10 V	A	out	out
	4-20 mA	B	in	in
	0-20 mA	B	out	out

		J3/1	J3/2	J3/3
Analogue Input #3	0-10 V	A	out	out
	4-20 mA	B	in	in
	0-20 mA	B	out	out

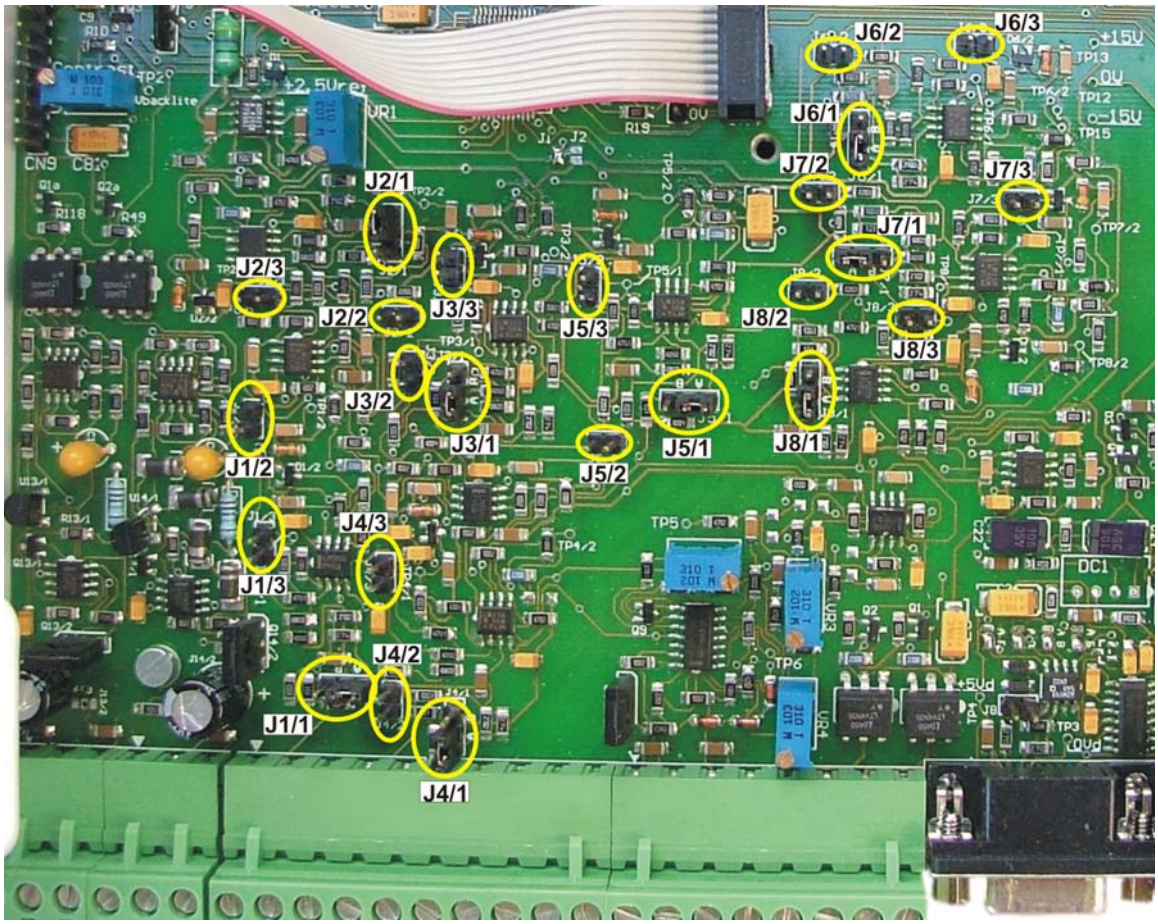
		J4/1	J4/2	J4/3
Analogue Input #4	0-10 V	A	out	out
	4-20 mA	B	in	in
	0-20 mA	B	out	out

		J5/1	J5/2	J5/3
Analogue Input #5	0-10 V	A	out	out
	4-20 mA	B	in	in
	0-20 mA	B	out	out

		J6/1	J6/2	J6/3
Analogue Input #6	0-10 V	A	out	out
	4-20 mA	B	in	in
	0-20 mA	B	out	out

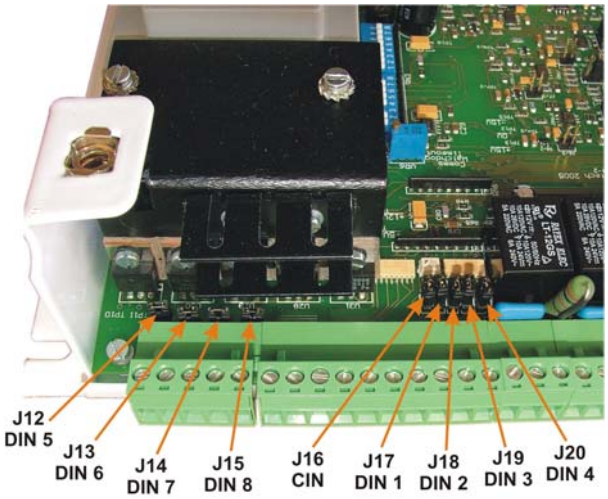
		J7/1	J7/2	J7/3
Analogue Input #7	0-10 V	A	out	out
	4-20 mA	B	in	in
	0-20 mA	B	out	out

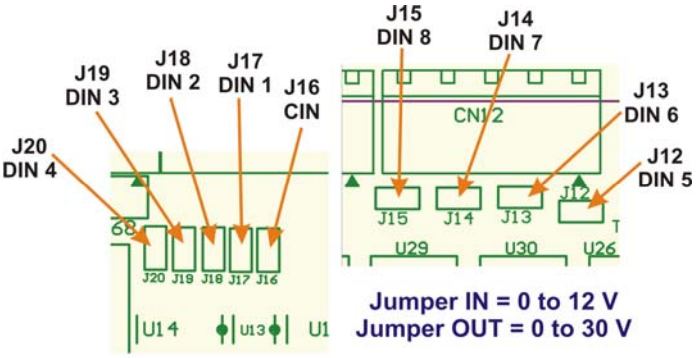
		J8/1	J8/2	J8/3
Analogue Input #8	0-10 V	A	out	out
	4-20 mA	B	in	in
	0-20 mA	B	out	out



Digital Inputs:

		0-12 V	0-30 V
Digital Input #1	J17	in	out
Digital Input #2	J18	in	out
Digital Input #3	J19	in	out
Digital Input #4	J20	in	out
Digital Input #5	J12	in	out
Digital Input #6	J13	in	out
Digital Input #7	J14	in	out
Digital Input #8	J15	in	out



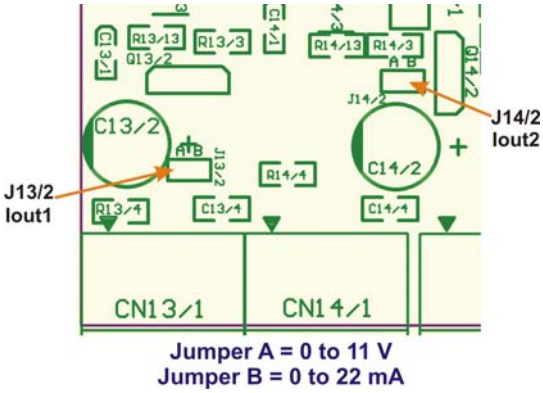


Counter Inputs:

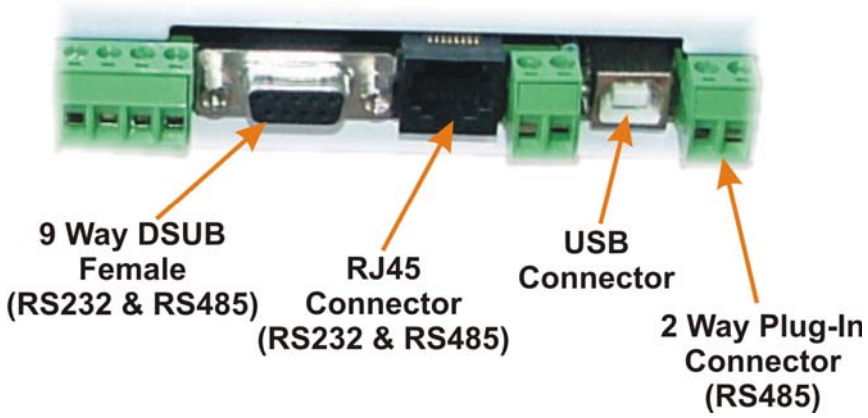
Counter Input		0-12 V	0-30 V
	J16	in	Out

Auxiliary Analogue Outputs:

		0-11 V	0-22 mA
Iout1	J13/2	A	B
Iout2	J14/2	A	B



13. Communicating with the MCI/2



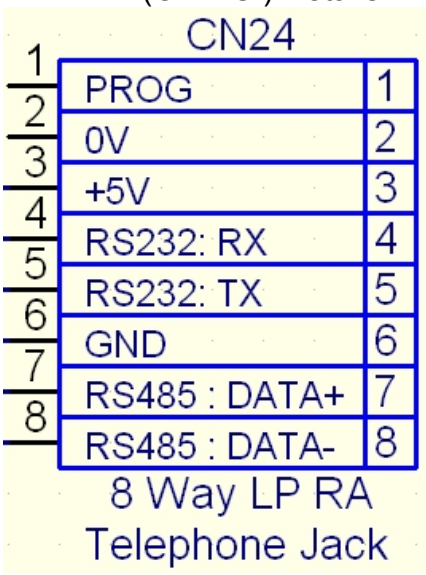
Communication with the MCI can be done in any of three ways – RS232, RS485 or USB. RS232 and RS485 connections are available on the 9 way DSUB and the RJ45 connectors. A two way plug-in screw terminal connector is provided for RS485 connection.

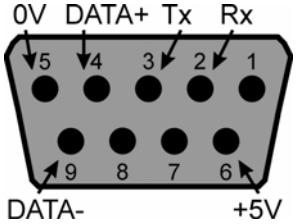
Only one device can be connected using the RS232 or USB connections but up to 32 devices (MCIs or any other Danntech Remote Magic Family products) can be connected using RS485.

9 Way DSUB Female Connector (On MCI) Details

Pin	Description
1	Not used
2	Rx - RS232
3	Tx - RS232
4	DATA+ RS485
5	0 V
6	+5 V
7	Not used
8	Not used
9	DATA- RS485

RJ45 Female Connector (On MCI) Details





14. Installing the USB Driver

In the USB Drivers folder on the MCI/2 CD you will find two documents: Windows_XP_Installation_Guide.pdf and Windows_98_Installation_Guide.pdf. These documents have details regarding the USB driver installation.

When using Win XP, plug in the MCI USB cable and you will be prompted to install drivers for the FT232BM which is the device used in the MCI/2.

Generally most MCI/2 users will require the second driver type which is the virtual COM port (VCP) driver. The VCP drivers emulate a standard PC COM port. These can be communicated with in the same manner as any other COM port on the PC.

Under Windows XP, the Found New Hardware Wizard should be used to install devices when they are connected to the PC for the first time as this is the recommended procedure for reliable device operation.

You need to install the drivers found on the MCI/2 CD in the “USB Drivers” folder.

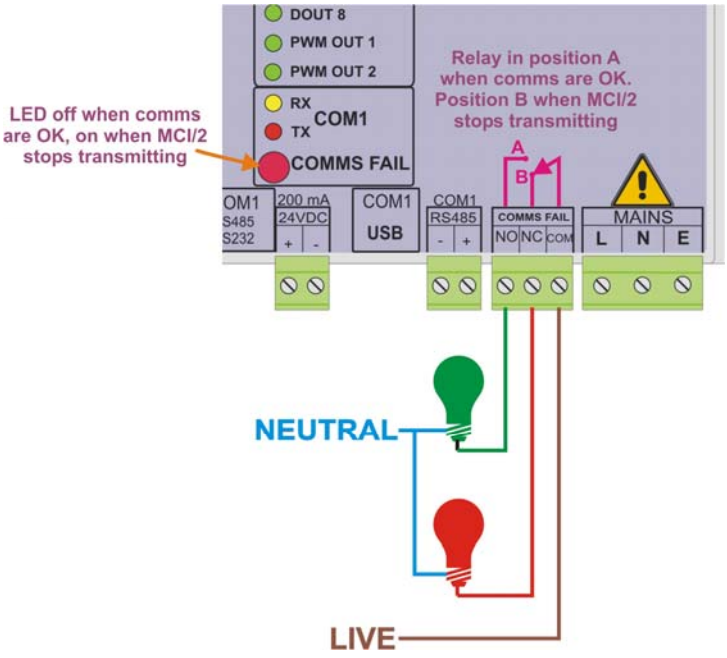
15. Communications Watchdog

The MCI/2 has a serial communications watchdog which provides a way of making sure that the MCI/2 and the controller keep working correctly.

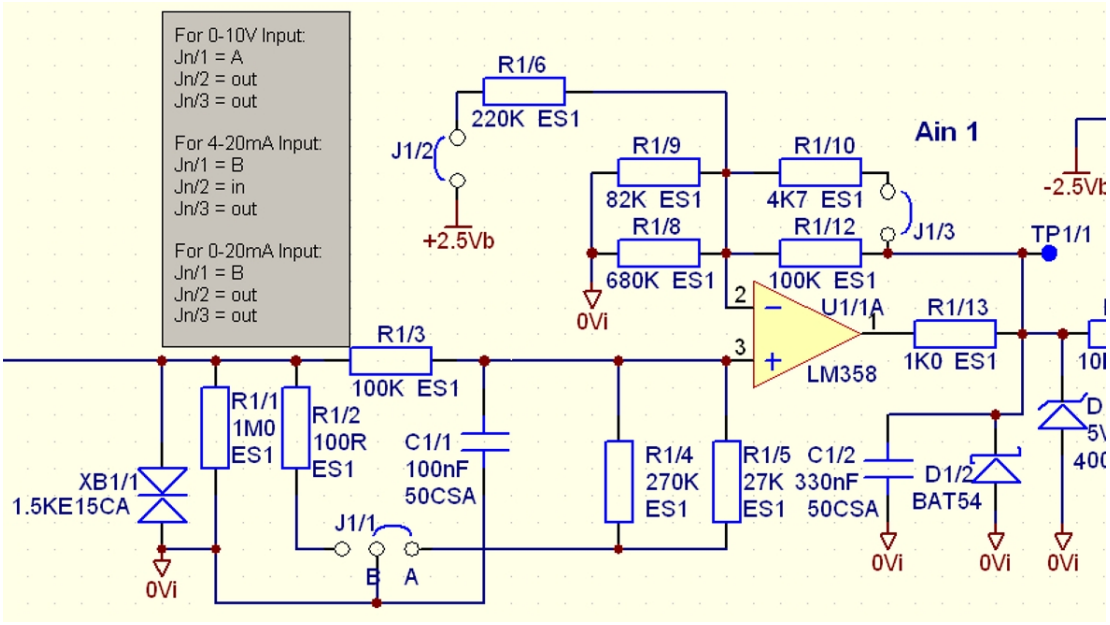
Each time the MCI/2 responds to a command (transmits) the internal watchdog is reset.

While the watchdog is reset periodically the red COMMS FAIL LED remains off and the COMMS FAIL relay remains closed. When the MCI/2 stops transmitting for whatever reason, for a preset period of time, then the watchdog times out and the red COMMS FAIL LED comes on and the COMMS FAIL relay opens.

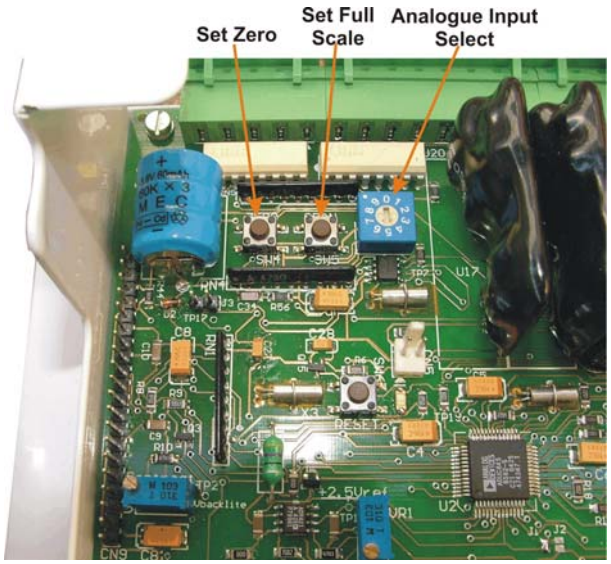
The trimpot adjustment when fully anti-clockwise produces a watchdog timeout of 1 second, fully clockwise produces a watchdog timeout of around 20 seconds.



16. Analogue Inputs



Calibration -
SW2.4 used for manual input calibration control (OFF=normal operation, ON=analogue input calibration). When manual calibration is selected the rotary switch SW3 selects the channel being calibrated and SW4 sets the zero and SW5 the full scale input values.

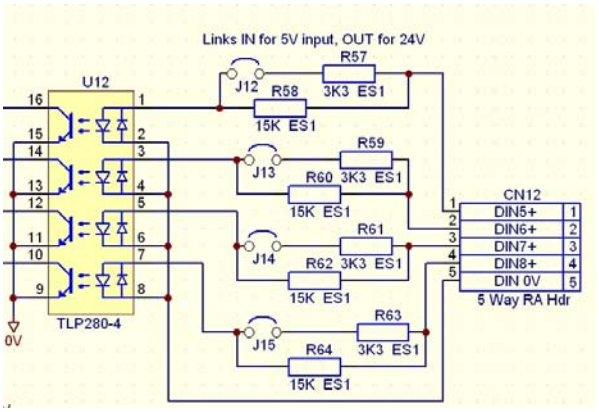


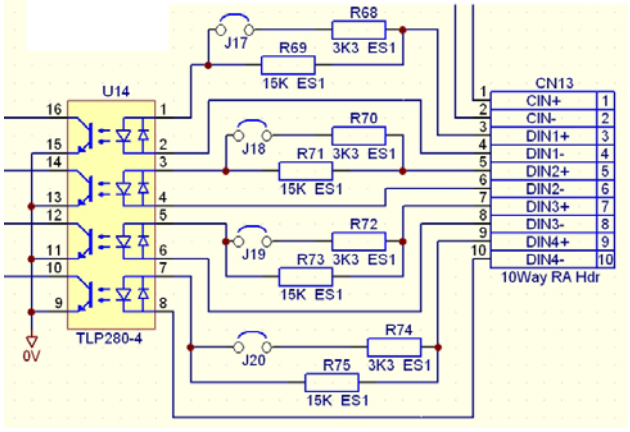
Inject the value you wish to have as zero for the input being calibrated, allow a few seconds to stabilize and then press the Set Zero button. Then inject the value you wish to have as the full scale value and after a few seconds press the Set Full Scale button. This sets up the value read back from the analogue input as 0 for the zero value and 65535 for the full scale value.

The LED near the CPU will flash three times when calibration measurements successful.

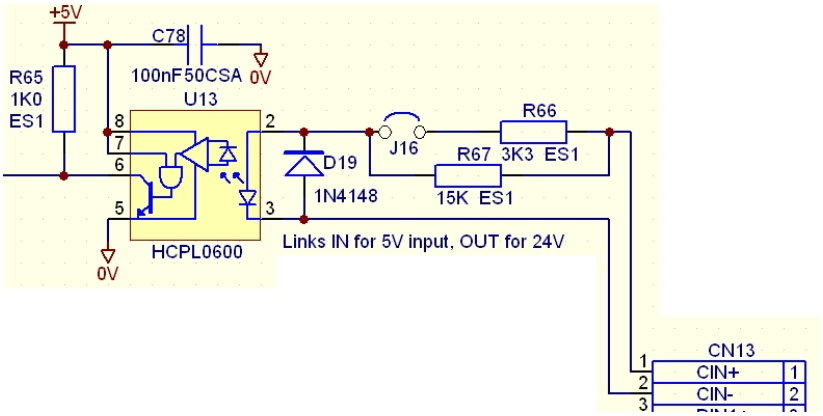
This same procedure can be done using the calibrate command and registers 84 through 99 for situations where access to the MCI/2 is difficult.

17. Digital Inputs

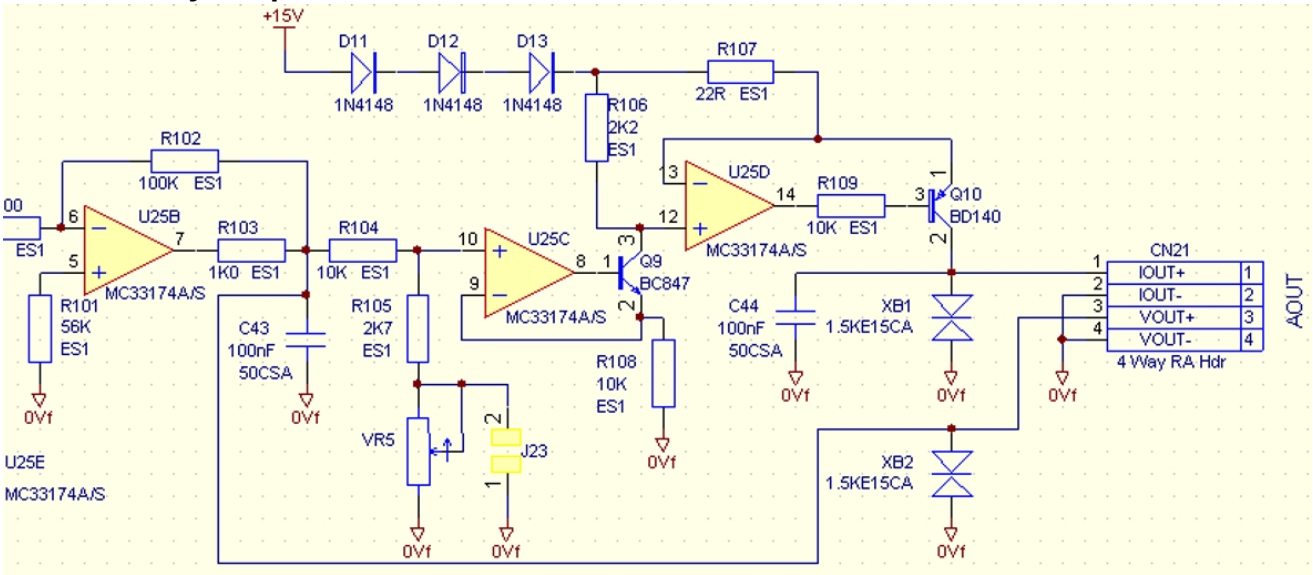


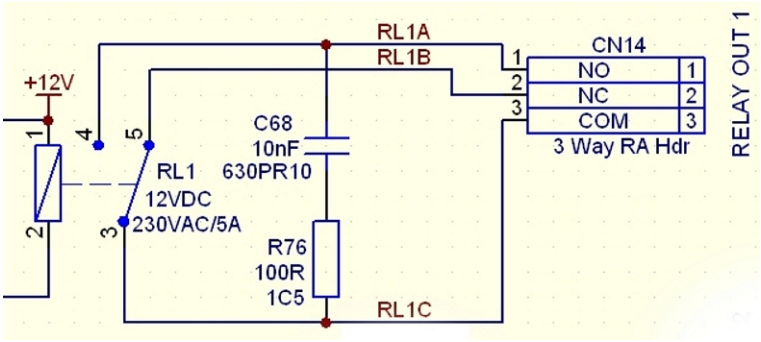


18. Counter Input

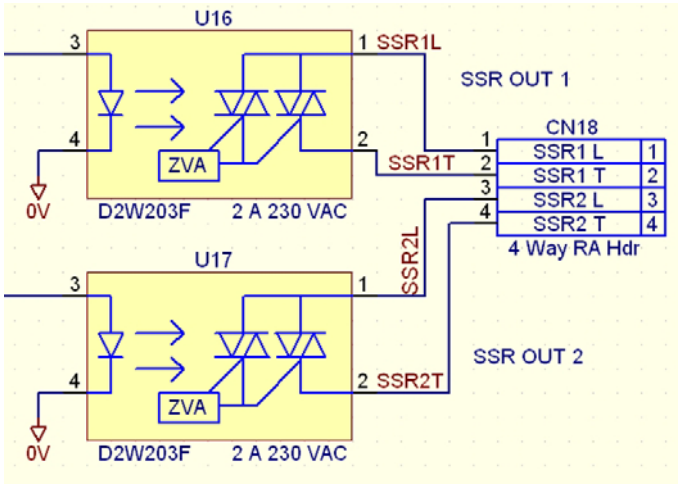


19. Analogue Outputs
20. Relay Outputs

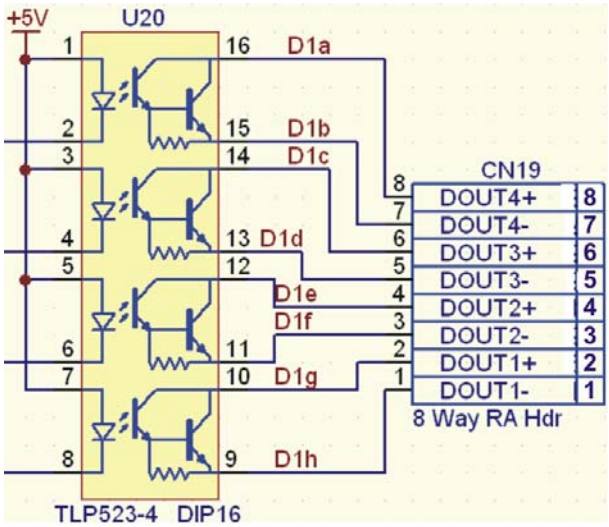




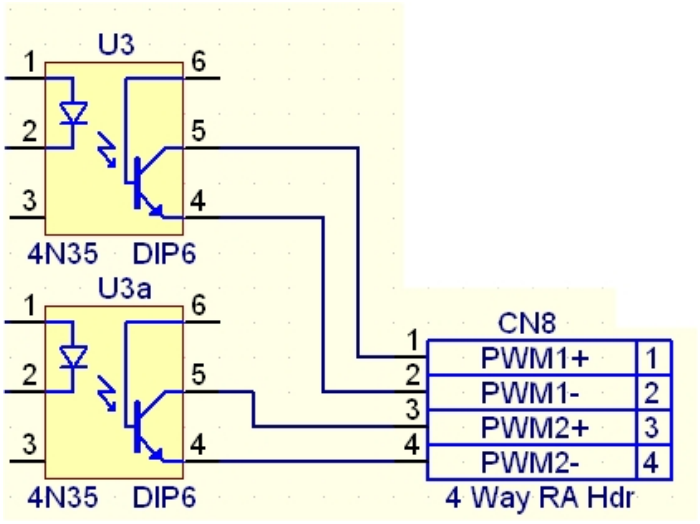
21. Solid State Relay Outputs



22. Digital Outputs



23. Pulse Width Modulated Outputs



24. Auxiliary I/O Connectors

Auxiliary Connector #1		Auxiliary Connector #2	
0V	1	1	0V
DIN1	2	2	LD1/1
DIN2	3	3	LD1/2
DIN3	4	4	LD1/3
DIN4	5	5	LD1/4
DIN5	6	6	LD1/5
DIN6	7	7	LD2/1
DIN7	8	8	LD2/2
DIN8	9	9	LD2/3
DOUT1	10	10	LD2/4
DOUT2	11	11	LD2/5
DOUT3	12	12	LD3/1
DOUT4	13	13	LD3/2
DOUT5	14	14	LD3/3
DOUT6	15	15	LD3/4
DOUT7	16	16	LD3/5
DOUT8	17	17	SLED
RLY1	18	18	WLED
RLY2	19	19	ALED
RLY3	20	20	BUZZ
RLY4	21	21	SW1
SSR1	22	22	SW2
SSR2	23	23	SW3
CIN	24	24	SW4
+5V	25	25	/INT
+12V	26	26	SCL
	27	27	SDA
	28	28	RA1
+5Vd	29	29	RA4
COM2 DATA+	30	30	RB0
COM2 DATA-	31	31	+5V
C2 RS232 RX	32	32	+5V
C2 RS232 TX	33	33	+12V
0Vd	34	34	+12V

25. Technical Specifications

Analogue Inputs:
Eight analogue inputs
Sixteen bit resolution
10 Hz input filter
Non-isolated with common zero volt connection
Link selectable current or voltage options
0 to 20 mA or 4 to 20 mA with 100 Ω input resistance
0 to 10 V with 470 kΩ input resistance
Input zero and full scale adjustment manually by means of rotary select switch and zero and full scale buttons or using software and the calibrate commands

Digital Inputs:
Eight digital inputs - four individually isolated, four with common 0V (0 to 12V or 0 to 30 V input)
Link selectable input voltage range options.

Voltage input option 0 to 12 V -	Vin < 1 V = digital 0
	Vin > 4 V = digital 1
	Input resistance = 3.3 kΩ
Voltage input option 0 to 30 V -	Vin < 8 V = digital 0
	Vin > 13 V = digital 1
	Vin max = 30 V
	Input resistance = 15 kΩ

Counter Inputs:
One sixteen bit counter
Isolated input 0 to 50 kHz
Link selectable voltage or current options

Voltage input option -	Vin < 1 V = digital 0
	Vin > 4 V = digital 1
	Vin max = 30 V
	input resistance = 1 kΩ
Current input option -	Iin < 10 mA = digital 0
	Iin > 18 mA = digital 1
	Iin max = 30 mA
	input resistance = 270 Ω

Analogue Output:
One analogue output
Ten bit resolution
10 Hz output filter
Non-isolated with common zero volt connection
Both current and voltage outputs available
0 to 20 mA or 4 to 20 mA with 500 Ω maximum load resistance
0 to 10 V with 2 kΩ minimum load resistance
Offset and span adjustment with multiturn trimpots

PWM Outputs:
Two pulse width modulated outputs
TTL 0 V to 5 V levels
Easy conversion to two eight bit analogue outputs
Frequency controllable from 50 Hz to 14 460 Hz in 255 steps
Duty cycle controllable from 0 to 100 % in 255 steps

Digital Outputs:
Four individually isolated digital outputs
Independent uncommitted NPN transistors with open collector and open emitter

Output transistor rating 30 V Vce max and 150 mA Ic max

Relay Outputs:
Four relay outputs
Both normally open and normally closed contacts available
Potential free contacts
Contacts AC rated at 250 VAC at 10 A
Contacts DC rated at 220 V DC at 1 A
RC series snubbing across both contacts of each relay
Snubber 10 nF 630 V capacitor in series with 100 Ω two watt resistor
Locations for the addition of transorbs or MOVs if required

Solid State Relay Outputs:
Two solid state relay outputs
Rated at 240 VAC at 3 A
Triac zero voltage switching

General:
Robust industrial enclosure
Power requirements 230 V or 115 VAC 50/60 Hz ±10 % at 20 VA
Built-in auxiliary 24 V 200 mA isolated DC supply for external devices
Operating temperature 0 to 70 °C
Plug-in screw terminal connections
Maximum wire size 1.5 mm^2
9 way DSUB interface connection
Vertical or horizontal mounting with four M5 or M6 screws for which holes are provided
Dimensions 290 x 190 x 62 mm (length x width x height)
Colour - powder coated white with front panel decal
MCI/2 weight is 3 kg
Packaging – white foam lined self-locking cardboard box 370 x 330 x 130 mm (length x width x height)
Weight of packaged MCI/2 with cables and user manual is 4 kg.

26. Delivery Configuration

R M Register #	Modbus Read Reg Address	Modbus Write Reg Address	Description	Default Value
17	40017	60017	Digital Output Power-up Word	0
28	40028	60029	Relay #1 Pulse Value Power-up Setting	0
29	40029	60030	Relay #2 Pulse Value Power-up Setting	0
30	40030	60030	Relay #3 Pulse Value Power-up Setting	0
31	40031	60031	Relay #4 Pulse Value Power-up Setting	0
32	40032	60032	Open Collector Output #1 Pulse Value Power-up Setting	0
33	40033	60033	Open Collector Output #2 Pulse Value Power-up Setting	0
34	40034	60034	Open Collector Output #3 Pulse Value Power-up Setting	0
35	40035	60035	Open Collector Output #4 Pulse Value Power-up Setting	0
36	40036	60036	Solid State Relay #1 Pulse Value Power-up Setting	0
37	40037	60037	Solid State Relay #2 Pulse Value Power-up Setting	0
45	40045	60045	Counter Timebase Value (n x 100 mSecs)	100
59	40059	60059	Counter Mode Power-up Value	2
60	40060	60060	Counter Timebase Power-up Value	100
62	40062	60062	LED Output Power-Up Word	0
64	40064	60064	Digital Output Toggle Control Power-up Control Word	0
67	40067	60067	LED Flash Control Register Power-up Control Word	0
69	40069	60069	PWM Mode Power-up Value	1
73	40073	60073	PWM Output #1 Duty Cycle Power-up Value	65535
75	40075	60075	PWM Output #2 Duty Cycle Power-up Value	65535
101	40101	60101	Analogue Output Power-up Value	0
106	40106	60106	Auxiliary LED/Buzzer Output Word Power-up Word	0
108	40108	60108	Auxiliary LED/Buzzer Flash Control Register Power-up Control Word	0

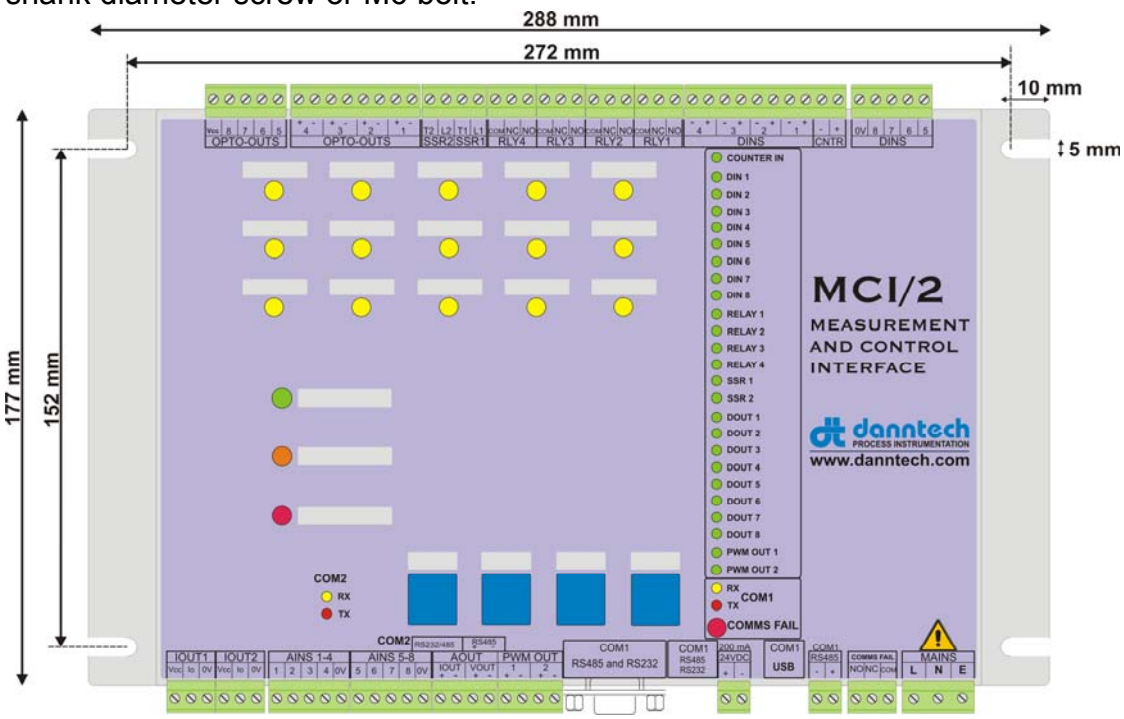
Analogue Inputs - all 0 to 10 V
Analogue Output - 0 to 10.5 V and 0 to 22.5 mA
Digital Inputs - all 0 to 30 VDC
Counter Input - 0 to 30 VDC
Auxiliary analogue outputs Iout1 and Iout2 - 0 to 22 mA (approximate)

Address = 1
SW2.1 = ON, comms can be either RS232, RS485 or USB.

The delivery configuration, address and communications speed are indicated on the side of the MCI/2.

27. Mounting the MCI/2

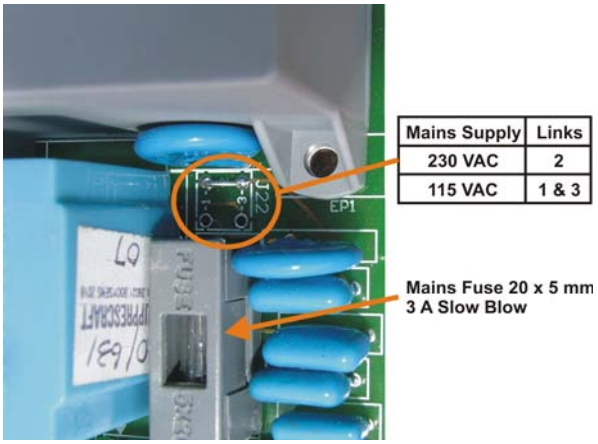
Distance between mounting hole centres 272 x 152 mm, with maximum 4 mm shank diameter screw or M6 bolt.



28. Input Power

The MCI/2 is normally configured for 230 VAC unless otherwise clearly marked otherwise. The soldered wire links of J22 must be changed for 115 VAC operation.

The input mains supply has a protection fuse, mains filter and surge protection. The fuse recommended is 20 x 5 mm, 3 A slow blow, 230 VAC.



29. Other Features Planned for the Future

29.1. Internal GSM modem.
29.2. Stand-alone data logging and GSM modem connection.
29.3. Second serial port for connection to additional serial communication devices.
29.4. 128 x 64 LCD display.
29.5. 24 or 12 VDC powered.
29.6. Low power option for battery powered data logging.
29.7. Compact DIN rail mounting version

30. Interface Protocol

When communicating with the MCI the following format must be observed:

@**address**, **command**, **register**, **data**, **checksum**

where:

@ - this character must be transmitted to signal the start of the command sequence

address - the MCI address as set by SW1.4 - SW1.8, (0 to 31).

command - the command (0 to 127):

1	Read Configuration
2	Read Registers
3	Write Registers
4	Synchronize Digital Outputs
5	Read Run Time
6	Read Raw Data
7	Read Bulk Data
8	Identify All Attached
9	Synchronize Digital Outputs

register - the register number as applicable to the respective command.

data - the data as applicable to the respective command.

checksum - the checksum is the sum of all the values (excluding the start character) modulo 2^{16}. Note that the checksum is a 16-bit number which wraps around through zero should the sum exceed 65535 i.e. if the sum of the data from the address through to data is 65537 then the checksum should be sent as 1.

All values are 16-bit except for the address and command and have a range of 0 to 65535.

Upon receipt of any command between 1 and 9 (i.e. checksum matches and command is recognized) the MCI will reply with a copy of the original command with the command value increased by 128 (i.e. the most significant bit is set); **data** is the requested data. The **checksum** is also updated to reflect the changes. For commands 4 (Synchronize Digital Outputs), 7 (Read Bulk Data) and command 8 (Identify All Attached) the MCI response is a little different (see later).

The command set and corresponding parameters are outlined below.

Command = 1, Read Configuration:

Returns the data preset into the device firmware relating to the number of inputs/outputs etc.

register = address of the register to be read-

0 - Device part number code (12 for this device)

1 - Firmware version number in the format zzzz/10 so 10 means version 1.0 and 43 version 4.3

2 - Number of digital outputs this unit has (10)

3 - Number of digital inputs this unit has (4)

4 - Number of analogue outputs this unit has (34 = 2-analogue output and start-up register + 2- digital output and start-up register + 20-pulse dividers and start-up registers + 8-PWM outputs and start-up registers + 2-counter value and mode)

5 - Number of analogue inputs this unit has (8)

6 - Imbedded serial number (can be written once and thereafter can only be read).

data = any value when transmitted to the device (usually zero), contains the requested configuration data upon return.

[The digital and analogue inputs and outputs relate to the Modbus protocol in which the digital outputs are read and write, digital inputs are read only, analogue inputs are read only and the analogue outputs are read and write.]

Command = 2 and 3, Read and Write Registers:

Read and Write Registers - Commands 2 and 3							
2 = read register		Allows access to the all the input and current output values and the DIP switch settings					
3 = write register		Allows writing to the all the output registers					
	Modbus	**Modbus**			**Power-up**		
R M	**Read**	**Write**			**Value**		**R M**
Register	**Reg**	**Reg**			**from**		**Power-up**
#	**Address**	**Address**	**Description**	**Range**	**EERAM**	**RM Mode**	**Register #**
1	40001	60001	Digital Input #1 (0 = off, 1 = on)	0 to 1	no	Read Only	
2	40002	60002	Digital Input #2 (0 = off, 1 = on)	0 to 1	no	Read Only	
3	40003	60003	Digital Input #3 (0 = off, 1 = on)	0 to 1	no	Read Only	
4	40004	60004	Digital Input #4 (0 = off, 1 = on)	0 to 1	no	Read Only	
5	40005	60005	Digital Input Word	0 to 255	no	Read Only	
6	40006	60006	Relay #1 (0 = off, 1 = on)	0 to 1	yes	Read and Write	bit #0 of reg 17
7	40007	60007	Relay #2 (0 = off, 1 = on)	0 to 1	yes	Read and Write	bit #1 of reg 17
8	40008	60008	Relay #3 (0 = off, 1 = on)	0 to 1	yes	Read and Write	bit #0 of reg 17
9	40009	60009	Relay #4 (0 = off, 1 = on)	0 to 1	yes	Read and	bit #0 of reg

						Write	17
10	40010	60010	Opto Output #1 (0 = off, 1 = on)	0 to 1	yes	Read and Write	bit #0 of reg 17
11	40011	60011	Opto Output #2 (0 = off, 1 = on)	0 to 1	yes	Read and Write	bit #0 of reg 17
12	40012	60012	Opto Output #3 (0 = off, 1 = on)	0 to 1	yes	Read and Write	bit #0 of reg 17
13	40013	60013	Opto Output #4 (0 = off, 1 = on)	0 to 1	yes	Read and Write	bit #0 of reg 17
14	40014	60014	Solid State Relay #1 (0 = off, 1 = on)	0 to 1	yes	Read and Write	bit #0 of reg 17
15	40015	60015	Solid State Relay #2 (0 = off, 1 = on)	0 to 1	yes	Read and Write	bit #0 of reg 17
16	40016	60016	Digital Output Word	0 to 65535	yes	Read and Write	17
17	40017	60017	Digital Output Power-up Word	0 to 65535	yes	Read and Write	
18	40018	60018	Relay #1 Pulse Value	0 to 65535	yes	Read and Write	28
19	40019	60019	Relay #2 Pulse Value	0 to 65535	yes	Read and Write	29
20	40020	60020	Relay #3 Pulse Value	0 to 65535	yes	Read and Write	30
21	40021	60021	Relay #4 Pulse Value	0 to 65535	yes	Read and Write	31
22	40022	60022	Opto Output #1 Pulse Value	0 to 65535	yes	Read and Write	32
23	40023	60023	Opto Output #2 Pulse Value	0 to 65535	yes	Read and Write	33
24	40024	60024	Opto Output #3 Pulse Value	0 to 65535	yes	Read and Write	34
25	40025	60025	Opto Output #4 Pulse Value	0 to 65535	yes	Read and Write	35
26	40026	60026	Solid State Relay #1 Pulse Value	0 to 65535	yes	Read and Write	36
27	40027	60027	Solid State Relay #2 Pulse Value	0 to 65535	yes	Read and Write	37
28 to 37			Digital Output Power-up registers				
38	40038	60038	PWM Output Frequency (for both PWM outputs)	0 to 255	yes	Read and Write	39
39	40039	60039	PWM Output Frequency Power-up Value (for both PWM outputs)	0 to 255	yes	Read and Write	
40	40040	60040	PWM Output #1 Duty Cycle	0 to 255	yes	Read and Write	41
41	40041	60041	PWM Output #1 Duty Cycle Power-up Value	0 to 255	yes	Read and Write	
42	40042	60042	PWM Output #2 Duty Cycle	0 to 255	yes	Read and Write	43
43	40043	60043	PWM Output #2 Duty Cycle Power-up Value	0 to 255	yes	Read and Write	
44			***not used***				
45	40045	60045	Counter Timebase Value	0 to 65535	yes	Read and Write	60
46	40046	60046	Counter Value	0 to 65535	no	Read Only	
47	40047	60047	Counter Mode	0, 1 or 2	yes	Read and Write	59
48	40048	60048	Analogue Input #1	0 to 1023	no	Read Only	
49	40049	60049	Analogue Input #2	0 to 1023	no	Read Only	

50	40050	60050	Analogue Input #3	0 to 1023	no	Read Only	
51	40051	60051	Analogue Input #4	0 to 1023	no	Read Only	
52	40052	60052	Analogue Input #5	0 to 1023	no	Read Only	
53	40053	60053	Analogue Input #6	0 to 1023	no	Read Only	
54	40054	60054	Analogue Input #7	0 to 1023	no	Read Only	
55	40055	60055	Analogue Input #8	0 to 1023	no	Read Only	
56	40056	60056	Analogue Output	0 to 1023	yes	Read and Write	57
57	40057	60057	Analogue Output Power-up Value				
58	40058	60058	DIP switch #1 setting in binary	0 to 255	no	Read Only	
59	40059	60059	Counter Mode Power-up Value	0 to 65535	yes	Read and Write	
60	40060	60060	Counter Timebase Power-up Value				
61	40061	60061	LED Output Word	0 to 65535	yes	Read and Write	62
62	40062	60062	LED Output Power-Up Word				
63	40063	60063	Digital Output Toggle Control Word	0 to 65535	yes	Read and Write	65
64	40064	60064	Digital Output Toggle Control Power-up Control Word				
65	40065	60065	Counter Overflow Register	0 to 65535	no	Read and Write	
66	40066	60066	LED Flash Control Register	0 to 65535	yes	Read and Write	67
67	40067	60067	LED Flash Control Register Power-up Control Word	0 to 65535	yes	Read and Write	
68	40068	60068	PWM Mode	0 or 1	yes	Read and Write	69
69	40069	60069	PWM Mode Power-up Value	0 or 1	yes	Read and Write	69
70	40070	60070	PWM Output Frequency (for both PWM outputs)	0 to 65535	yes	Read and Write	71
71	40071	60071	PWM Output Frequency Power-up Value (for both PWM outputs)	0 to 65535	yes	Read and Write	
72	40072	60072	PWM Output #1 Duty Cycle	0 to 65535	yes	Read and Write	73
73	40073	60073	PWM Output #1 Duty Cycle Power-up Value	0 to 65535	yes	Read and Write	
74	40074	60074	PWM Output #2 Duty Cycle	0 to 65535	yes	Read and Write	75
75	40075	60075	PWM Output #2 Duty Cycle Power-up Value	0 to 65535	yes	Read and Write	
76	40076	60076	Analogue Input #1	0 to 65535	no	Read Only	
77	40077	60077	Analogue Input #2	0 to 65535	no	Read Only	
78	40078	60078	Analogue Input #3	0 to 65535	no	Read Only	
79	40079	60079	Analogue Input #4	0 to 65535	no	Read Only	

80	40080	60080	Analogue Input #5	0 to 65535	no	Read Only	
81	40081	60081	Analogue Input #6	0 to 65535	no	Read Only	
82	40082	60082	Analogue Input #7	0 to 65535	no	Read Only	
83	40083	60083	Analogue Input #8	0 to 65535	no	Read Only	
84	40084	60084	Analogue Input #1 Zero Calibrate Value	0 to 65535	yes	Read and Write	
85	40085	60085	Analogue Input #1 Full Scale Calibrate Value	0 to 65535	yes	Read and Write	
86	40086	60086	Analogue Input #2 Zero Calibrate Value	0 to 65535	yes	Read and Write	
87	40087	60087	Analogue Input #2 Full Scale Calibrate Value	0 to 65535	yes	Read and Write	
88	40088	60088	Analogue Input #3 Zero Calibrate Value	0 to 65535	yes	Read and Write	
89	40089	60089	Analogue Input #3 Full Scale Calibrate Value	0 to 65535	yes	Read and Write	
90	40090	60090	Analogue Input #4 Zero Calibrate Value	0 to 65535	yes	Read and Write	
91	40091	60091	Analogue Input #4 Full Scale Calibrate Value	0 to 65535	yes	Read and Write	
92	40092	60092	Analogue Input #5 Zero Calibrate Value	0 to 65535	yes	Read and Write	
93	40093	60093	Analogue Input #5 Full Scale Calibrate Value	0 to 65535	yes	Read and Write	
94	40094	60094	Analogue Input #6 Zero Calibrate Value	0 to 65535	yes	Read and Write	
95	40095	60095	Analogue Input #6 Full Scale Calibrate Value	0 to 65535	yes	Read and Write	
96	40096	60096	Analogue Input #7 Zero Calibrate Value	0 to 65535	yes	Read and Write	
97	40097	60097	Analogue Input #7 Full Scale Calibrate Value	0 to 65535	yes	Read and Write	
98	40098	60098	Analogue Input #8 Zero Calibrate Value	0 to 65535	yes	Read and Write	
99	40099	60099	Analogue Input #8 Full Scale Calibrate Value	0 to 65535	yes	Read and Write	
100	40100	60100	Analogue Output	0 to 4095	yes	Read and Write	101
101	40101	60101	Analogue Output Power-up Value	0 to 4095	yes	Read and Write	
102	40102	60102	Analogue Output Zero Offset Value	0 to 65535	yes	Read and Write	
103	40103	60103	Analogue Output Full Scale Multiplier Value	0 to 65535	yes	Read and Write	
104	40104	60104	DIP switch #2 setting in binary	0 to 255	no	Read Only	
105	40105	60105	Aux LED/Buzzer Output Word	0 to 65535	yes	Read and Write	106
106	40106	60106	Aux LED/Buzzer Output Word Power-up Word				
107	40107	60107	Aux LED/Buzzer Flash Control Register	0 to 65535	yes	Read and Write	108
108	40108	60108	Aux LED/Buzzer Flash Control Register Power-up Control Word	0 to 65535	yes	Read and Write	
109	40109	60109	Push Button Switch Input Word	0 to 65535	no	Read Only	

Using the Pulsing Features of the Digital Outputs

All the digital outputs can be used in the pulse output mode. In this mode the output pulse rate can be set by writing to the respective “output pulse value register”. A specified power-up pulse value can also be specified for each digital output which is accessed by the respective “output pulse power-up value” which is stored in EERAM.

It is recommended that to begin with 0 is written to registers 63 and 64 to make sure that the output pulsing is initially disabled.

Simple on/off control can be used by writing a 0 or a 1 to the various output registers. Using values other than 0 or 1 the other pulsing features can be used. The various states are determined by writing other values to the digital outputs. These are best described using a table format:

bit 3 = enables or disables bit 2
bit 2 = the new pulsing output state
bit 1 = enables or disables bit 1
bit 0 = new output state

bit 3	bit 2	bit 1	bit 0	Decimal	Description
0	0	0	0	0	If 63 = 0 then simple on/off. If pulsing is enabled then will set output **OFF** until the next state changed as defined by the pulse settings.
0	0	0	1	1	If 63 = 0 then simple on/off. If pulsing is enabled then will set output **ON** until the next state changed as defined by the pulse settings.
0	0	1	0	2	Leaves pulse state unchanged - sets output **OFF**. Same effect as writing 0.
0	0	1	1	3	Leaves pulse state unchanged - sets output **ON**. Same effect as writing 1.
0	1	0	0	4	No effect.
0	1	0	1	5	No effect.
0	1	1	0	6	Same effect as writing 0.
0	1	1	1	7	Same effect as writing 1.
1	0	0	0	8	Disable pulsing and leave output in its current state.
1	0	0	1	9	Disable pulsing and leave output in its current state.
1	0	1	0	10	Disable pulsing and set output **OFF**.
1	0	1	1	11	Disable pulsing and set output **ON**.
1	1	0	0	12	Enable pulsing and leave output in its current state.
1	1	0	1	13	Enable pulsing and leave output in its current state.
1	1	1	0	14	Enable pulsing and set output **OFF** initially.
1	1	1	1	15	Enable pulsing and set output **ON** initially.

Note that register 63 can be used to enable or disable pulsing on all of the digital outputs all together. Register 64 simply defines weather the various digital outputs will have the pulsing feature enable or disabled at power-up. This value is stored in EERAM.

Command = 4, Read and Write Registers:

Calibrate analogue inputs and outputs.

Command = 5, Read Run Time:

Returns the approximate length of time the MCI has been running since the last power-up.

register = address of the register to be read-
0 - seconds
1 - minutes
2 - hours
3 - days

data = returns the data requested

Command = 6, Read Raw Data:

Returns the unscaled or uncalibrated data read from the analogue inputs.

Command = 7, Read Bulk Data:

Allows the user to read blocks of data instead of single data values.

The command structure is the same as before i.e.

@address, command, register, data, checksum

where command is the allocated command number = 7

Now instead of simply sending all the registers back to the control module the MCI will now send a range of registers. These registers are specified by a start address contained in the *register* parameter and an end address stored in the *data* portion of the command string. Having received the command the module will transmit the registers in a single stream of values, separated by commas and terminated with a CR/LF combination.

After the stream of data the original command is echoed to the host with the command value updated as normal (128 added to the command value). The “data” returned in the echoed command however is the checksum of the block transfer data. This echoed command will be ended with the standard checksum validating the echoed command and its data.

Thus with the MCI at address 0, to obtain the analogue input values with 9.32 V applied to inputs 1 to 4 and 0.988 V applied to inputs 5 to 8 the following command could be used:

@0,7,48,55,110

The reply would be:

953,952,963,952,99,99,99,100
0,135,48,4217,4400

Where the first line 953, ... 100 represent the analogue input values (0 to 1023) and the second line can be broken down as follows:

0 = the echo of the device address
135 = the command echoed with the highest bit set i.e. 128 added to the original command sent to the MCI
48 = the echo of the starting register address
4217 = the checksum of the first line values
4400 = the checksum of the second line values

If the MCI detects a discrepancy between the calculated checksum and the transmitted checksum then the command is ignored. The master must then time out and take appropriate action.

If the master does not receive the correct reply it must assume that the command was not received by the slave.

Command = 8, Identify All Attached:

This command allows the control module to quickly identify all modules attached to the RS485 interface.

The command structure is the same as before i.e.

@address, command, register, data, checksum

Where the address, the register and the data values are ignored (so any values can be sent) and the checksum is calculated as usual.

In response to this command, each attached MCI replies after a delay of its address*10 mSec. This ensures that within 450 mSecs all the modules attached are identified (maximum of 32 modules).

The various attached modules would reply with the following:

address, device part number code, checksum

Where the address is the replying module address and the device part number is 12.

Command = 9, Synchronize Digital Outputs:

This command provides a means of synchronizing any of the digital outputs so that they switch on and off together. It works as follows:

@address, 9, outputselect, syncvalue, checksum

Where the address and checksum are calculated as for the other commands and

outputselect = a word 0 to 65535 in which the setting of the various bits determines which of the digital outputs are to be synchronized.

Bit 0 = Relay #1
Bit 1 = Relay #2
Bit 2 = Relay #3
Bit 3 = Relay #4
Bit 4 = Open Collector Output #1
Bit 5 = Open Collector Output #2
Bit 6 = Open Collector Output #3
Bit 7 = Open Collector Output #4
Bit 8 = Solid State Relay #1
Bit 9 = Solid State Relay #2

syncvalue = a word value made up with the individual bits indicate what value 0 or 1 the selected output should inherit.

When the MCI receives this command it analyses which outputs are to be affected (as determined by the *outputselect* parameter) and adjusts the internal counters used on each output such that they will toggle at the same time starting with a “set” state. The other outputs are not affected by this command and continue operating how they were last configured.

So for example using an MCI at address 1, to synchronize Relay #1 and Open Collector Output #1 so that Relay #1 is on and Open Collector Output #1 is off the following command is used:

@1,9,17,1,28

The 17 is derived by setting bits 0 (Relay #1) and 4 (Open Collector Output #1) and the 1 is to set bit 4 in the OFF state and bit 0 in the ON state at synchronization.